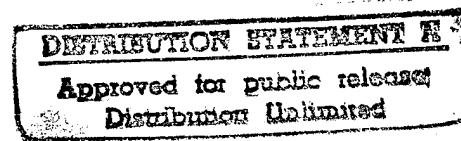


G & G
-2013

ANNU

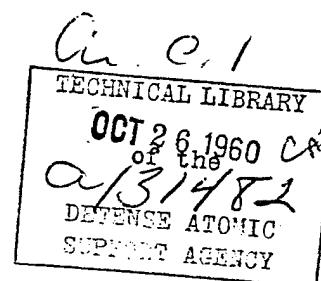


EDGERTON, GERMESHAUSEN & GRIER, INC.

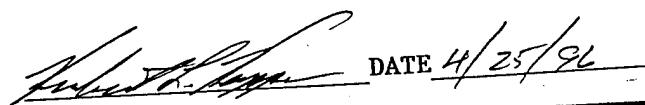


FIREBALL CALCULATIONS
SHOT HAMILTON
OPERATION HARDTACK PHASE II
PROJECT 15.1

19960702 073



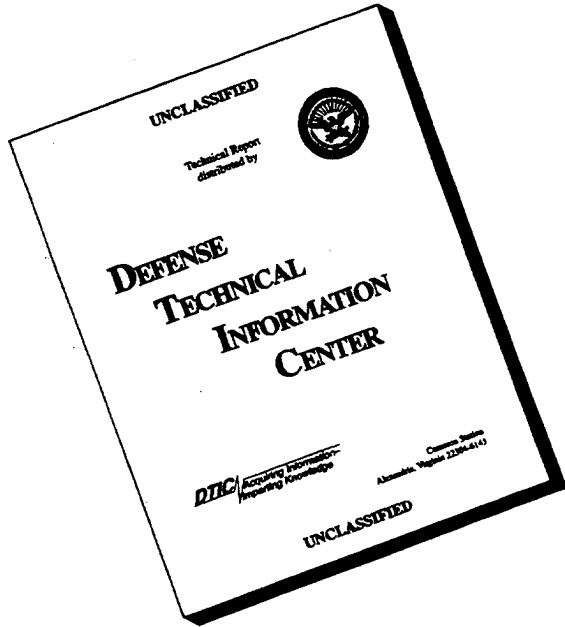
DISTRIBUTION STATEMENT A APPLIES
PER NTPR REVIEW.


DATE 4/25/96

BOSTON, MASSACHUSETTS • LAS VEGAS, NEVADA
SANTA BARBARA, CALIFORNIA

REPORT NO. B-2013
29 JANUARY 1960

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Defense Nuclear Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398



ISST

29 May 1996

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OCD/Mr. Bill Bush

SUBJECT: Documents for DTIC System

There is no record of your office receiving the following reports:

EGG-B-2024 (29 January 1960)
Fireball Calculations Shot Sanford
Operation Hardtack Phase II
Project 15.1

EGG-B-2013 (29 January 1960)
Fireball Calculations Shot Hamilton
Operation Hardtack Phase II
Project 15.1

Both documents are now approved for public release.

Therefore, we are transmitting copies for inclusions into the DTIC system, if not already there.

Enclosure:
A/S

Ardith Jarrett
ARDITH JARRETT
Chief, Technical Support

DTIC QUALITY INSPECTED

FIREBALL CALCULATIONS

SHOT HAMILTON

OPERATION HARDTACK, PHASE II

PROJECT 15.1

Report No. B-2013
29 January 1960

Prepared by R. C. Schneiderhan
R. C. Schneiderhan

Approved by D. F. Seacord Jr.
D. F. Seacord, Jr.

EDGERTON, GERMESHAUSEN & GRIER, INC.
Boston, Mass. Santa Barbara, Calif. Las Vegas, Nev.

FIREBALL CALCULATIONS: SHOT HAMILTON

1.0 INTRODUCTION

Shot Hamilton, a 50-foot tower shot sponsored by LRL, was detonated at 0800 PST, on 15 October 1958 in Area TF-1 of the Nevada Test Site. The fireball yield was $0.43 \text{ ton} \pm 0.09 \text{ ton}$.

2.0 CAMERA INSTRUMENTATION AND OPERATION (Table 1)

Photographic coverage of Hamilton fireball growth was provided by two high-speed Eastman cameras and one high-speed 16 mm Fastax camera at Station 527.01 (6 x 6 No. 2) and a similar camera complement at Station 527.02 (6 x 6 No. 3). In addition, two Rapatronic cameras were located at Station 527.01 to record early fireball growth. The EG&G framing camera, running at an approximate speed of 15,000 frames per second, was located at Station F-732 (6 x 6 No. 1) to record additional early fireball behavior. One Eastman camera from Station 527.02 did not record the complete fireball. All other cameras obtained records suitable for analysis.

The station locations and the burst location are shown in Fig. 1. Figure 2 contains a summary of the survey data.

3.0 RESULTS

Because the yield of Hamilton was well below the range of constant ϕ^5 scaling¹, the ϕ comparison technique as defined in EG&G Report No. B-1869, "Fireball Calculations - Shot Eddy", was employed to determine the yield. A yield of $0.43 \text{ ton} \pm 0.09 \text{ ton}$ is indicated.

¹ ϕ^5 scaling is usually applicable only for yields greater than 2 kt.

An air density of 1.098 grams per liter was used in the yield calculations. The air density value was based upon a pressure of 910 millibars, a temperature of 15.0°C, and a relative humidity of 30 percent at shot time.

The table below gives the comparison shots, and the Hamilton yield obtained by the # - comparison.

Comparison Shot	Hamilton Yield (tons)
<u>Balloon</u>	
La Place	0.495
Wheeler	0.374
Santa Fe	0.499
Lea	0.452
Hidalgo	0.450
<u>Air Drop</u>	
Buster B	0.404
Wasp	0.408
Ranger A	0.398
Wasp	0.419
Ranger E	0.423

Comparison Shot	Hamilton Yield (tons)
<u>Tower</u>	
Hornet	0, 422
UK-3	0. 419
Rio Arriba	0. 456
Quay	<u>0. 431</u>
	<u>$\overline{W} = 0. 432$</u>

Diameter vs time and ϕ vs time plots are shown in Figs. 3, 4,

and 5.

The following data sheets are included for each film:

- (a) Photo Plan and Photo Loading Chart
- (b) Camera Data and Calculation Sheet
- (c) Diameter Measurement Sheet
- (d) E102 print-out sheet of D, t, and ϕ .

Selected frames of fireball films are contained in the Appendix.

The zero-frame times of the motion picture camera records were determined by comparing these records with the Rapatronic diameter vs time data.

18 min / for

FIG. 2
SURVEY
DATE 10-15-58

SURVEY DATA

FIG. 2

G7 STA T F /

DATA

EDGERTON, GERMESHAUSEN & GRIER INC.

FORM E17(1-55 500) NAME Analysis

KELLOGG MIC -59-6
KEUFFEL & ESSER CO., MADE IN U.S.A.
2 CYCLES X 70 DIVISIONS

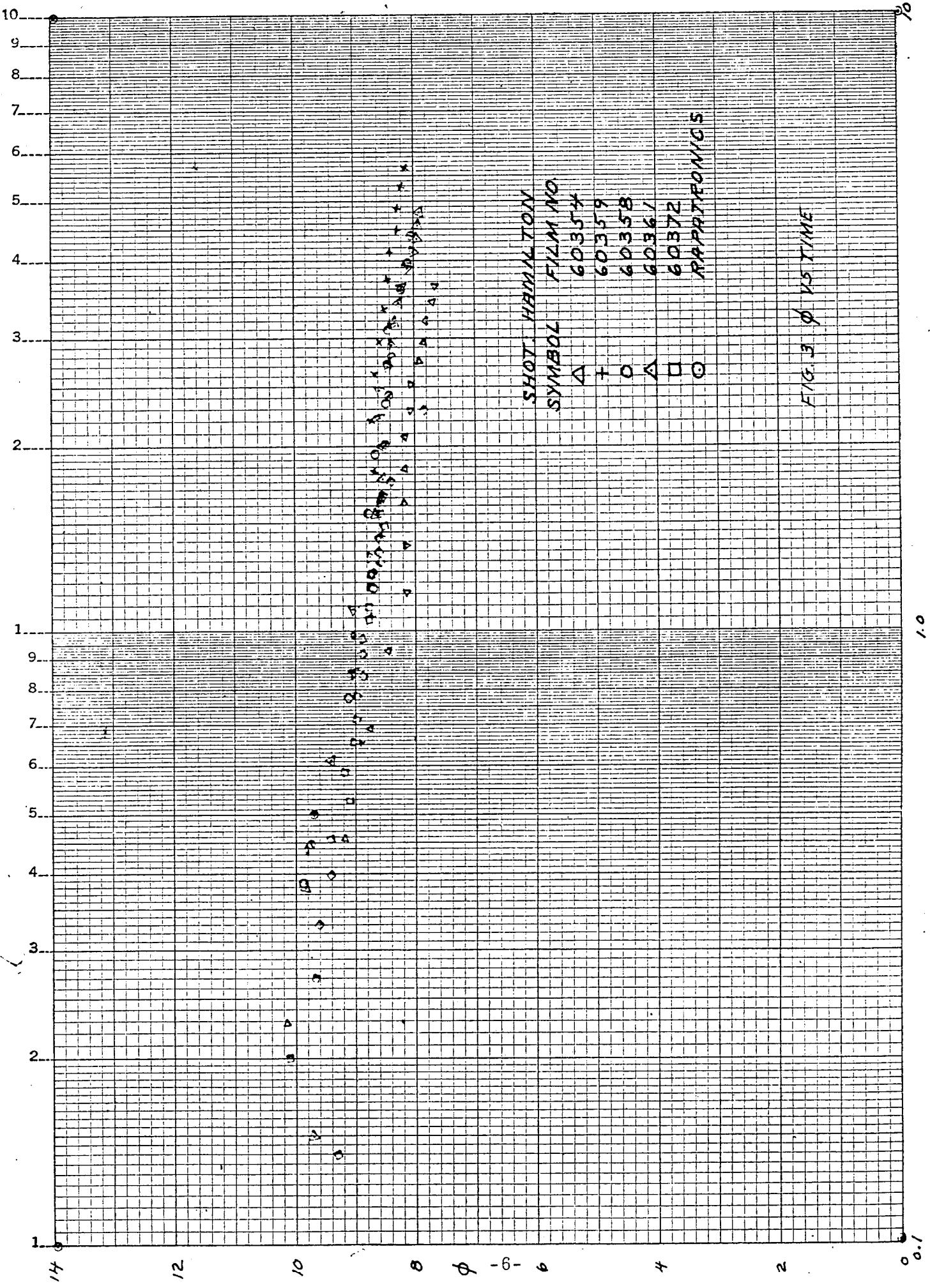
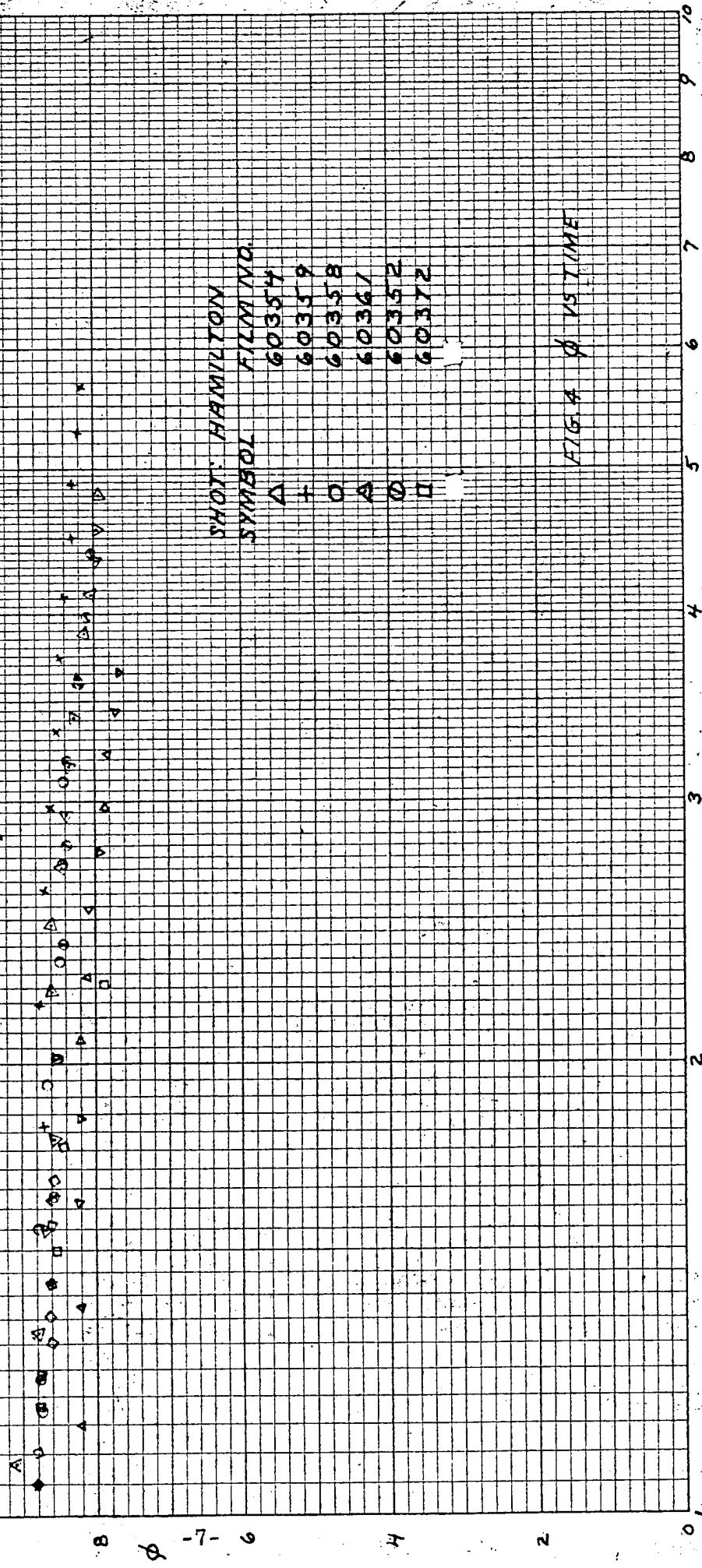


FIG. 4 of 10 TIME



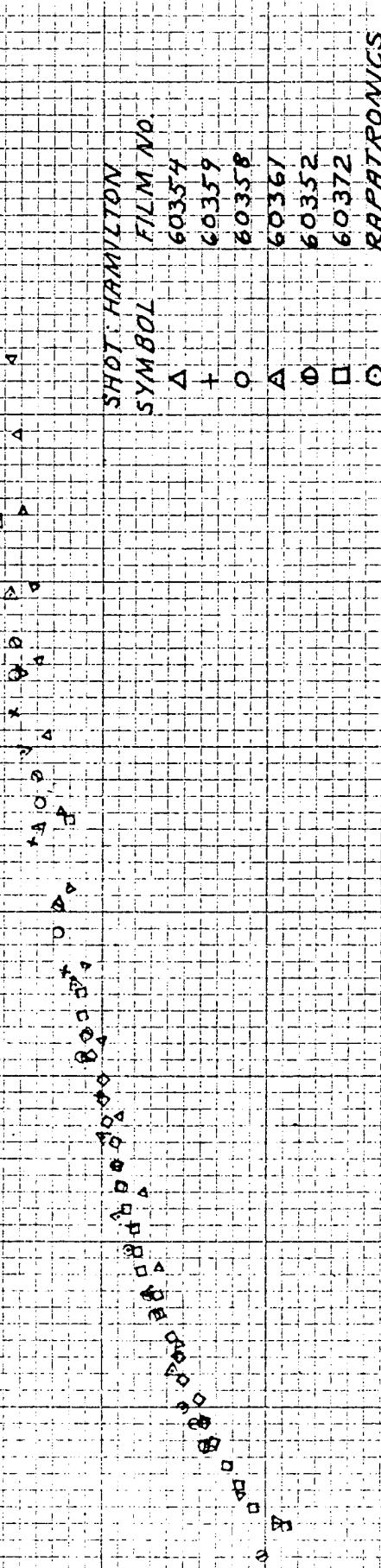


FIG. 5 DIAMETER VS TIME

Table I
 Hardtack Phase II, Hamilton
 Fireball Camera Distribution

Station	Camera	Qualitative Functioning
527.01 (6 x 6 No. 2)	E-34	Record
	E-7	Poor Image
	F-16 No. 2	Record
	R-4	Record
	R-3	Record
527.02 (6 x 6 No. 3)	E-25	Part of F. B. Obscured
	E-6	Record
	F-16 No. 1	Record
F-732 (6 x 6 No. 1)	FR No. 1	Record

Table II
Hardtack Phase II, Hamilton
Average Diameter vs Time

Time (in msec.)	Diameter(meters) as seen from Stations 527.01, 527.02 and F-732
0.5	7.3
1.0	9.0
1.5	10.3
2.0	11.2
2.5	12.2
3.0	12.8
3.5	13.4
4.0	14.2
4.5	14.7

Table III

Hardtack Phase II, Hamilton

Rapatronic Summary

Station	Film No.	Camera	Horizontal Range (m)	F. L. (mm)	Diameter(m)	Time(msec)
527.01 (6 x 6 No. 2)	60366	R-4	1196.6	477.39	7.37	0.4995
	60365	R-3	1196.6	477.82	8.99	0.9840

STATION NO. 527.01

STATION NO. 529.01

PHOTO PLAN

EVENT_HAMILTON

BRG 66°18'

STATION TYPE 6x6 + 2

STATION TYPE 6x6 + Z
DISTANCE GZ 1196.6'

DIFF.

STATION

GZ

Tilt

DISTANCE GZ // 96.6

N 747 339
E 713 933

$$\begin{array}{r} 48 \\ \times 20 \\ \hline 960 \end{array}$$

DATE 10-15-54
POSTED 10-15-54

+ 0°00'
2°24'

ASSISTANCE OBJECT

REMARKS - Rev#2 10-5-58 Rev #2 10-14-58

~~at~~ Inclades 50' bright at tower

Envoi

TATION NO. 502702 **TATION TYPE** 6x6 #3
INSTANCE GZ 1220.5' **INSTANCE OBJECT** 1221.4'

PHOTO PLAN

PHOTO PLAN		BRG	358°21'
STATION		DIFF.	TILT
N	746600	247 820	-0°01'
E	715064	215 029	-35°
Z	3063	3 1292	46°

EVENT HAMILTON
GZ STA. TF 1
DATE 10-15-55
POSTED 10-15-55

STATION NO. F-732 STATION TYPE 6x6 ~~4~~
DISTANCE GZ 1981.8' DISTANCE OBJECT 1982

PHOTO PLAN

BRG 30° 15'

EVENT_HANDBOOK

STATION N 2446119
INSTANCE GZ 1981.6 E 214012
INSTANCE OBJECT 1982.41

STATION	G Z	DIFF.
N 246119	247 820	1701
E 214012	215 029	1017
Z 3051	3 129	48

92-21A.

DIFF.	TILT	DATE
1701	GZ - 0°3'	10-15-58
1017	OBJ /023'	POSTED
		10-15-58

CAMERA	LENS			FIELD TARGET			AIMING			POWER			MARKER		PUR-POSE	REMARKS
	NOM. SPD.	RACK POS.	FOC. MM	S/N	FILTER	H/V	OBJECT	H	V	VOLTS	SHUT RHEO.	TIME ON/OFF	TYPE	S/N		
CR# 15000	-	15"	4498/66	W-12			FB	0°0'		115 AC 240 C	MAX / 415	200	/	-	MF 15.1	

REMARKS -

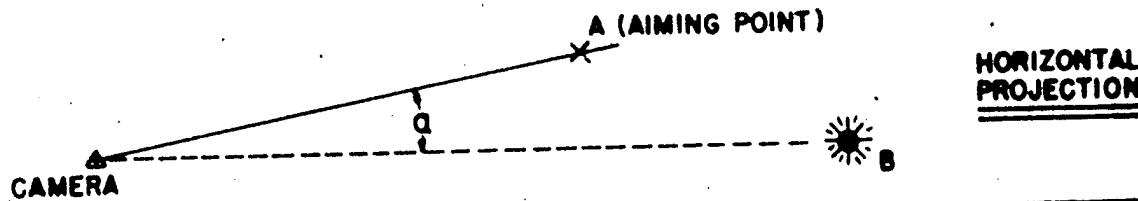
~~Includes 50' height of tower.~~

卷之三

BOSTONIAN. OCTOBER 20, 1837.

CAMERA DATA & CALCULATIONS

FILM NO. 60366	STATION NO. 527.01 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. R3	EQ. AP.		DATE: 10/15/58



A. $R/A = CB_h \cos a \cos \beta + (H_B - H_C) \sin \beta$

$a = 0^\circ 00'$	$\beta = 2^\circ 12'$	$H_B = 3129\text{ ft}$
$\cos a = 1.0000$	$\cos \beta = 0.99926$	$H_C = 3079\text{ ft}$
$CB_h = 364.7\text{ m}$	$\sin \beta = 0.03839$	$\Delta H = 50\text{ ft} = 15.2\text{ m}$
$CB_h \cos a \cos \beta = 364.4\text{ m}$	$\Delta H \sin \beta = 0.6\text{ m}$	$R/A = 365.0\text{ m}$

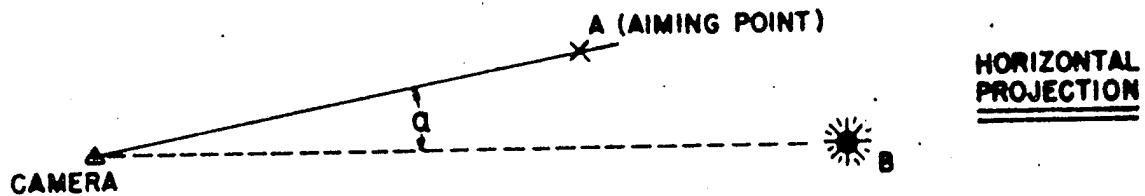
B. FOCAL LENGTH 477.39 mm (774699)

C. MAGNIFICATION FACTOR (meters/in.) 19.43

D. ZERO TIME CORRECTION 0.9840 ms delay

CAMERA DATA & CALCULATIONS

FILM NO. 60365	STATION NO. 527.01 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. R4	EQ. AP.		DATE: 10/15/58



A. $R^0/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$

$\beta = 2^\circ 12'$

$H_B = 312.9 \text{ ft}$

$\cos \alpha = 1.0000$

$\cos \beta = 0.99926$

$H_C = 307.9 \text{ ft}$

$CB_h = 364.7 \text{ m}$

$\sin \beta = 0.03839$

$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$

$CB_h \cos \alpha \cos \beta = 364.4 \text{ m}$

$\Delta H \sin \beta = 0.6 \text{ m}$

$R^0/A = 365.0 \text{ m}$

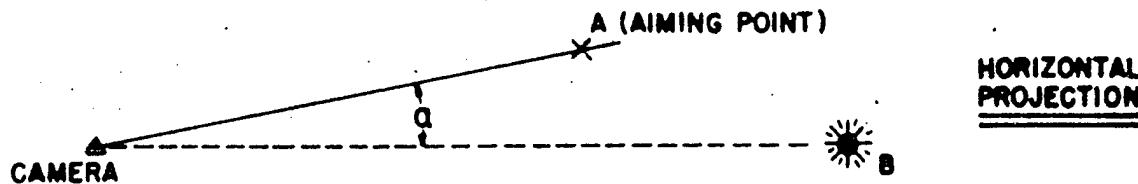
B. FOCAL LENGTH 477.82 mm (773952)

C. MAGNIFICATION FACTOR (meters/in.) 19.41

D. ZERO TIME CORRECTION 0.4995 ms delay

CAMERA DATA & CALCULATIONS

FILM NO. 60359	STATION NO. 527.0/ 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. E7	EQ. AP.		DATE: 10/15/58



A. $R^0/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 2^\circ 45'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99885$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.04798$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.3 \text{ m}$	$\Delta H \sin \beta = 0.7 \text{ m}$	$R^0/A = 365.0 \text{ m}$

B. FOCAL LENGTH 64.1 mm (ET-1207)

C. MAGNIFICATION FACTOR (meters/in.) 144.6

D. ZERO TIME CORRECTION 0.28 ms

DIA METER MEASUREMENTS

SHOT HAMILTON

FILM NO. 60359

READ BY

PLW

GGO

TYPED BY

DATE

10/23/58

DATE

REMARKS:

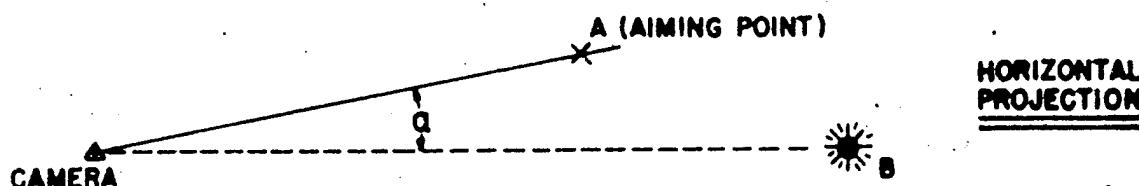
FIREBALL CALCULATIONS

SHOT HamiltonFILM NO. 60359DATE 1-22-59

D	t	In D	Int	$t^{2/5}$	ϕ
7.58	.66	2.02551	41559 -	846845	8950
8.95	1.05	2.19172	4876	1019697	8777
9.95	1.44	2.29750	36469	1157056	8599
11.10	1.82	2.40687	59887	1270678	8735
12.08	2.21	2.49149	79293	1373243	8796
12.73	2.60	2.54394	95543	1465468	8686
13.33	2.98	2.59003	109189	1547680	8612
13.88	3.37	2.63048	121494	1625763	8537
14.40	3.76	2.66728	132448	1698585	8477
14.88	4.14	2.70009	142077	1765278	8429
15.23	4.53	2.72334	151077	1829989	8322
15.73	4.91	2.75565	159129	1889885	8323
16.05	5.30	2.77579	166768	1948525	8236
16.40	5.69	2.79736	173865	2004633	8181

CAMERA DATA & CALCULATIONS

FILM NO. 60358	STATION NO. ^{527.01} _{6x6 #2}	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. E34	EQ. AP.		DATE: 10/15/58



A. $R^{\circ}/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^{\circ} 00'$	$\beta = 2^{\circ} 04'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99935$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.03606$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.5 \text{ m}$	$\Delta H \sin \beta = 0.55 \text{ m}$	$R^{\circ}/A = 3651 \text{ m}$

B. FOCAL LENGTH 101.6 mm (RC 128)

C. MAGNIFICATION FACTOR (meters/in.) 91.27

D. ZERO TIME CORRECTION 0.004 ms

DIA METER MEASUREMENTS

E-34

SHOT Hamilton

FILM NO. 60358

READ BY *[Signature]* **TYPED BY** _____

DATE 10/15/58 10/15/58 DATE

REMARKS:

TYPESET BY

DATE

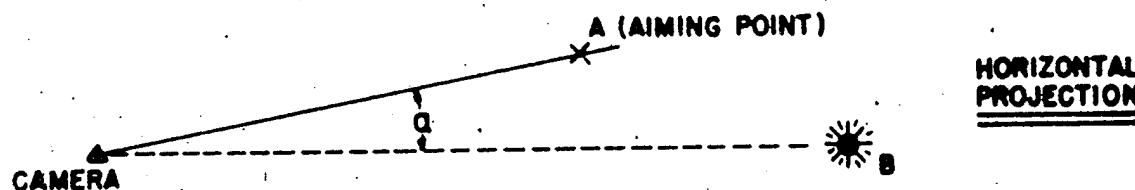
FIREBALL CALCULATIONS

SHOT Hamilton FILM NO. 60358DATE 1-22-59

D	t	ln D	Int	$t^{2/5}$	ϕ
6.80	.39	1.91685	.94153 -	.686180	99.09
8.32	.78	2.11872	248.44 -	0.05399	91.89
9.32	1.17	2.23221	156.03	10.64784	87.52
10.55	1.56	2.35609	444.76	11.94711	88.30
11.31	1.94	2.42561	662.69	13.03533	86.76
11.94	2.33	2.47983	845.79	14.02588	85.12
12.63	2.72	2.53604	1000.56	14.92163	84.64
13.32	3.11	2.58927	1134.61	15.74355	84.60

CAMERA DATA & CALCULATIONS

FILM NO. 60361	STATION NO. 527.01 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. F-16 #2	EQ. AP.		DATE: 10/15/58



A. $R^0/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 2^\circ 15'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99923$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.03926$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.4 \text{ m}$	$\Delta H \sin \beta = 0.6 \text{ m}$	$R^0/A = 365.0 \text{ m}$

B. FOCAL LENGTH 78.06 mm (617086)

C. MAGNIFICATION FACTOR (meters/in.) 118.8

D. ZERO TIME CORRECTION 0.15 ms

DIAMETER MEASUREMENTS

SHOT Hamilton

FILM NO. 60361

READ BY

GCO

LW

TYPED BY

DATE

10/28/58

DATE

REMARKS:

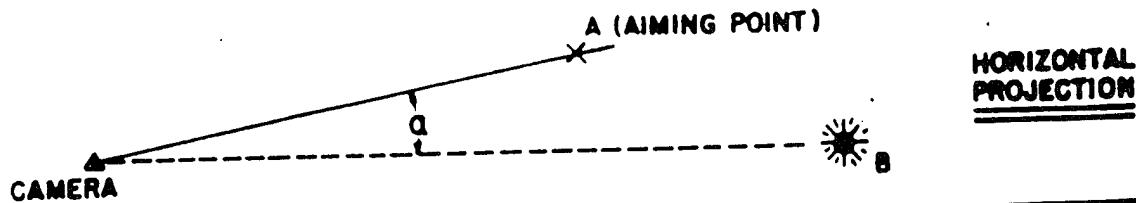
FIREBALL CALCULATIONS

SHOT Hamilton FILM NO. 60361DATE 1-22-59

D	t	ln D	Int	$t^{2/5}$	ϕ
4.58	.15	1.52174	1.89705 -	.468217	9.781
6.74	.38	1.90799	96751 -	679086	99.25
7.79	.61	2.05285	49437 -	820574	94.93
8.53	.85	2.14366	16245 -	937085	91.02
9.39	1.08	2.23968	7690	1031239	91.05
9.86	1.32	2.28844	27763	1117454	88.23
10.36	1.55	2.33795	43833	1191642	86.93
10.79	1.78	2.37856	57666	1259438	85.67
11.34	2.02	2.42826	70308	1324763	85.60
11.94	2.25	2.47983	81086	1383128	86.32
12.41	2.48	2.51846	90818	1438027	86.29
12.64	2.72	2.53684	100056	1492163	84.70
12.93	2.95	2.55954	108177	1541426	83.88
13.25	3.18	2.58400	115688	1588441	83.41
13.54	3.42	2.60567	122967	1635373	82.79
13.81	3.65	2.62542	129478	1678525	82.27
14.02	3.88	2.64053	135591	1720068	81.50
14.18	4.12	2.65188	141592	1761863	80.48
14.39	4.35	2.66659	147024	1800558	79.91
14.67	4.58	2.68587	152174	1838039	79.81
14.94	4.82	2.70411	157280	1875959	79.63

CAMERA DATA & CALCULATIONS

FILM NO. 60352	STATION NO. 527.02 6x6 #3	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. E 6	EQ. AP.		DATE: 10/15/58



A. $R^0/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 2^\circ 10'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99929$	$H_C = 3083 \text{ ft}$
$B_h = 372.0 \text{ m}$	$\sin \beta = 0.03781$	$\Delta H = 46 \text{ ft} = 14 \text{ m}$
$B_h \cos \alpha \cos \beta = 371.7 \text{ m}$	$\Delta H \sin \beta = 0.5 \text{ m}$	$R^0/A = 372.2 \text{ m}$
FOCAL LENGTH 63.91 mm (ET 1254)		

MAGNIFICATION FACTOR (meters/in.) 147.9

ZERO TIME CORRECTION 0.05 ms

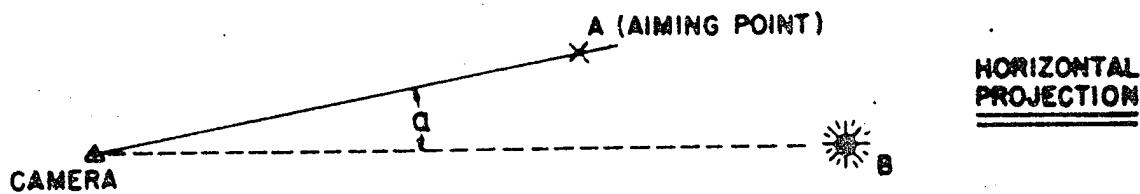
FIREBALL CALCULATIONS

SHOT Hamilton FILM NO. 60352DATE 1-22-59

t	$\ln D$	$\ln t$	$t^{2/5}$	ϕ
.05	1.61343	2.99572 -	.301722	166.37
.45	1.96286	798.45 -	7265.07	97.99
.84	2.14248	174.29 -	9326.57	91.35
1.23	2.25342	206.96	10863.09	87.63
1.63	2.34563	488.65	12158.73	85.86
2.02	2.42384	703.08	13247.63	85.22
2.41	2.48568	879.55	14216.53	84.47
2.81	2.54158	1033.13	15117.26	84.00
3.20	2.59452	1163.15	15924.32	84.08
3.60	2.62252	1280.99	16692.87	82.49
3.99	2.65047	1383.86	17394.12	81.40
4.38	2.68040	1477.11	18055.14	80.80

CAMERA DATA & CALCULATIONS

FILM NO. 60354	STATION NO. 527.02 6x6 #3	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. F16 #1	EQ. AP.		DATE: 10/15/58



A. $R^0/A = CB_h \cos a \cos \beta + (H_B - H_C) \sin \beta$

$a = 0^\circ 00'$	$\beta = 2^\circ 10'$	$H_B = 312.9 \text{ ft}$
$\cos a = 1.0000$	$\cos \beta = 0.99929$	$H_C = 308.3 \text{ ft}$
$CB_h = 372.0 \text{ m}$	$\sin \beta = 0.03781$	$\Delta H = 46 \text{ ft} = 14 \text{ m}$
$CB_h \cos a \cos \beta = 371.7 \text{ m}$	$\Delta H \sin \beta = 0.5 \text{ m}$	$R^0/A = 372.2 \text{ m}$

B. FOCAL LENGTH 77.96 mm (617071)

C. MAGNIFICATION FACTOR (meters/in.) 121.3

D. ZERO TIME CORRECTION 0.002 ms

DIAMETER MEASUREMENTS

milton

FILM NO. 60354

18

CCO JBC

TYPESET BY

• 18 •

10/28/58

DATE

URKS!

**EDGERTON, GERMESHAUSEN
& GRIER, INC.**

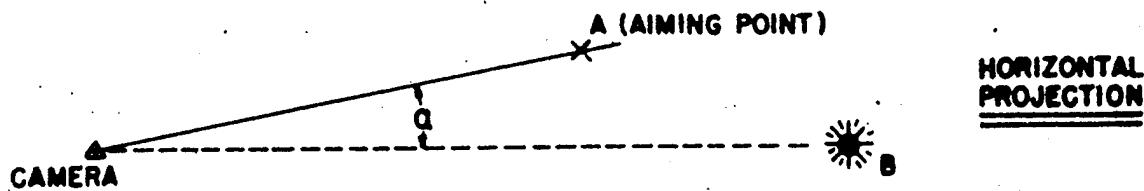
FIREBALL CALCULATIONS

by FILM NO. 60354DATE 1-22-59

In D	Int	$t^{2/5}$	ϕ
33 36	1.46974 -	.5 55493	101 89
12 43	776 48 -	7 33011	92 35
28 14	371 12 -	8 62042	88 16
06 62	83 32 -	9 67219	84 98
59 94	139 68	10 57464	81 98
35 42	322 11	11 37514	82 19
02 66	476 31	12 09884	82 65
47 54	609 80	12 76243	81 95
96 01	727 52	13 37776	82 07
26 49	832 84	13 95338	81 12
62 93	928 14	14 49555	80 99
80 67	1015 17	15 00904	79 61
01 38	1091 89	15 47680	78 82
25 69	1166 27	15 94422	78 39
40 00	1235 51	16 39194	77 35
60 31	1300 25	16 82199	76 92

CAMERA DATA & CALCULATIONS

NO. 60372	STATION NO. ^{F-732} _{6x6 #1}	TEST HAMILTON	CALCULATED BY: GGO
ERA NO. FR #1	EQ. AP.		DATE: 10/15/58



$$R/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$$

$0^{\circ} 00'$

$\beta = 1^{\circ} 23'$

$H_B = 312.9 \text{ ft}$

$\alpha = 1.0000$

$\cos \beta = 0.99971$

$H_C = 308.1 \text{ ft}$

$= 604.1 \text{ m}$

$\sin \beta = 0.02414$

$\Delta H = 48 \text{ ft} = 14.6 \text{ m}$

$\cos \alpha \cos \beta = 603.9 \text{ m}$

$\Delta H \sin \beta = 0.4 \text{ M}$

$R/A = 604.3 \text{ m}$

FOCAL LENGTH

MAGNIFICATION FACTOR (meters/in.)

ZERO TIME CORRECTION 0.006 ms

DIAMETER MEASUREMENTS

~~spor~~ Hamilton

FILM NO. 60372

Fr. No.	Mag.	D ₁	D ₂	D ₃	D _{avg} (m)	FLEXOWRITER	
						D _{avg} (m)	t (ms) xx.x
0	19.33	xxxx	xxxx		—	—	—
1		xxxx	xxxx		—	—	0.14
2		0134	0139		4.26	—	0.20
3		0169	0176		5.31	—	0.27
4		0182	0190		5.77	—	0.33
5		0198	0200		6.19	—	0.40
6		0212	0211		6.56	—	0.46
7		0222	0230		6.94	—	0.53
8		0235	0235		7.10	—	0.59
9		0249	0249		7.49	—	0.66
10		0253	0255		7.67	—	0.72
11		0257	0259		7.89	—	0.79
12		0267	0265		8.19	—	0.85
13		0273	0276		8.34	—	0.92
14		0279	0283		8.65	—	0.98
15		0281	0286		8.87	—	1.05
16		0288	0289		8.97	—	1.11
17		0297	0301		9.18	—	1.18
18		0300	0304		9.36	—	1.24
19		0306	0307		9.53	—	1.31
20		0312	0314		9.58	—	1.37
21		0317	0320		9.81	—	1.44
22		0325	0326		9.96	—	1.50
23		0329	0330		10.02	—	1.57
24		0335	0336		10.33	—	1.63
25		0336	0341		10.46	—	1.69
26		0342	0343		10.55	—	1.76
27		0348	0349		10.56	—	2.28
35		0354	0355		10.99	—	—

READ BY

JEC RCS

TYPED BY JEC

DATE

1/14/59

DATE

1/14/59

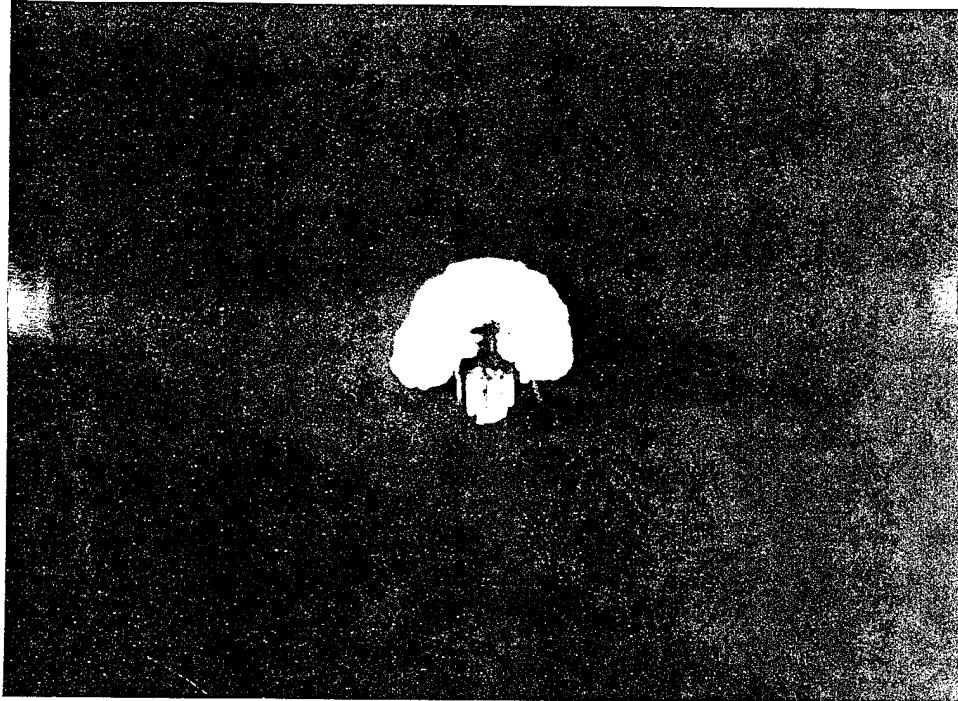
REMARKS:

FIREBALL CALCULATIONS

SHOT Hamilton FILM NO. 60372DATE 1-22-59

D	t	In D	Int	$t^{2/5}$	ϕ
4.26	.14	1.44934	1.96607 -	.4 55467	93.53
5.31	.20	1.66956	1.60945 -	5.25303	101.08
5.77	.27	1.75260	1.70940 -	5.92298	97.41
6.19	.33	1.82285	1.10864 -	6.41812	96.44
6.56	.40	1.88091	9.1621 -	6.93164	94.63
6.94	.46	1.93724	7.7648 -	7.33011	94.67
7.10	.53	1.96005	6.3490 -	7.75720	91.52
7.49	.59	2.01355	5.2770 -	8.09707	92.50
7.67	.66	2.03732	4.1559 -	8.46845	90.57
7.89	.72	2.06562	3.2854 -	8.76851	89.98
8.19	.79	2.10296	2.3569 -	9.10028	89.99
8.34	.85	2.12112	1.6245 -	9.37085	88.99
8.65	.92	2.15763	8.332 -	9.67219	89.43
8.87	.98	2.18275	2.023 -	9.91939	89.42
8.97	1.05	2.19396	4.876	10.19697	87.96
9.18	1.11	2.21709	10.428	10.42596	88.04
9.36	1.18	2.23649	16.544	10.68416	87.60
9.53	1.24	2.25446	21.506	10.89836	87.44
9.58	1.31	2.25969	27.002	11.14057	85.99
9.81	1.37	2.28337	31.483	11.34208	86.49
9.96	1.44	2.29851	36.469	11.57056	86.08
10.02	1.50	2.30465	40.553	11.76111	85.19
10.33	1.57	2.33505	45.115	11.97769	86.24
10.46	1.63	2.34754	48.865	12.15873	86.02
10.55	1.69	2.35609	52.479	12.33578	85.52
10.56	1.76	2.35704	56.537	12.53761	84.22
10.99	2.28	2.39692	82.411	13.90473	79.03

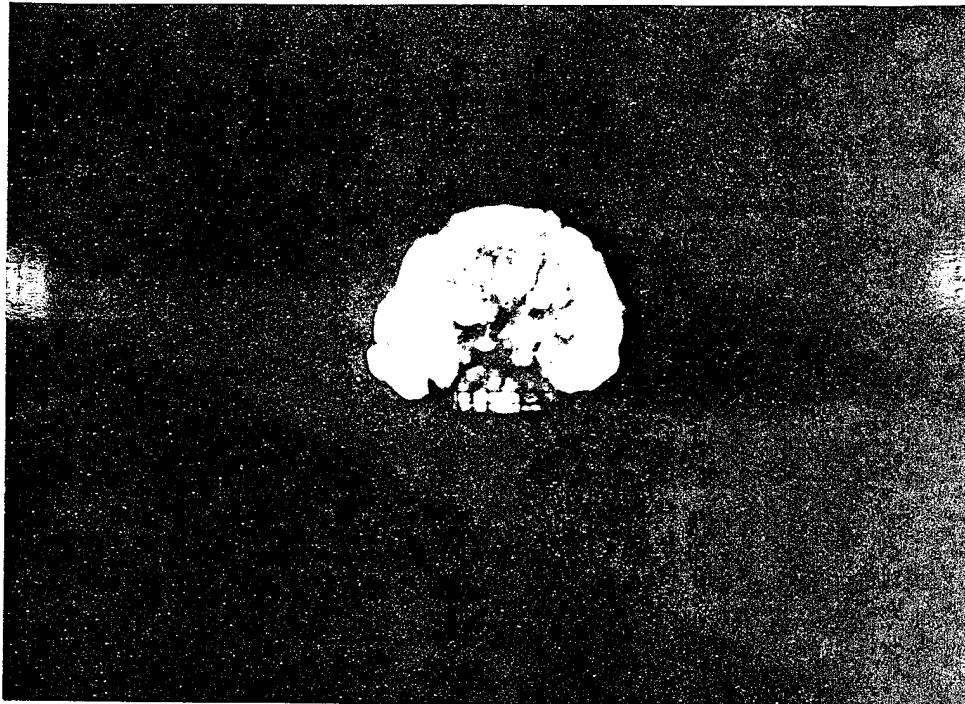
APPENDIX
HARDTACK PHASE II, HAMILTON
PHOTOGRAPHIC EXAMPLES



Camera: F-16 No. 2

Station: 527.01

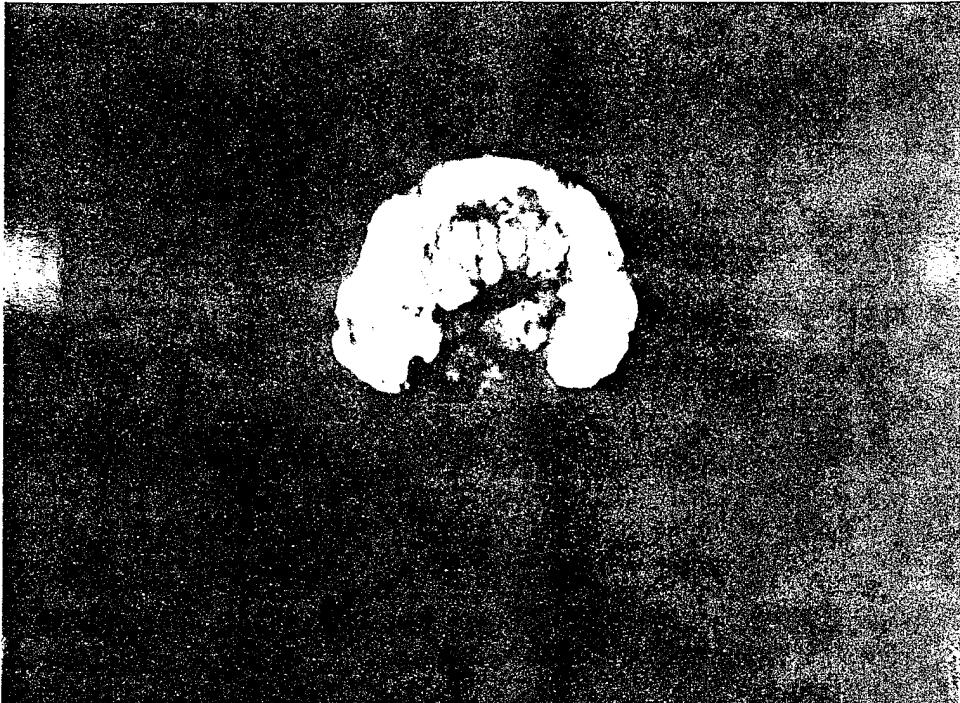
Time: 0.38 msec



Camera: F-16 No. 2

Station: 527.01

Time: 1.08 msec



Camera: F-16 No. 2

Station: 527.01

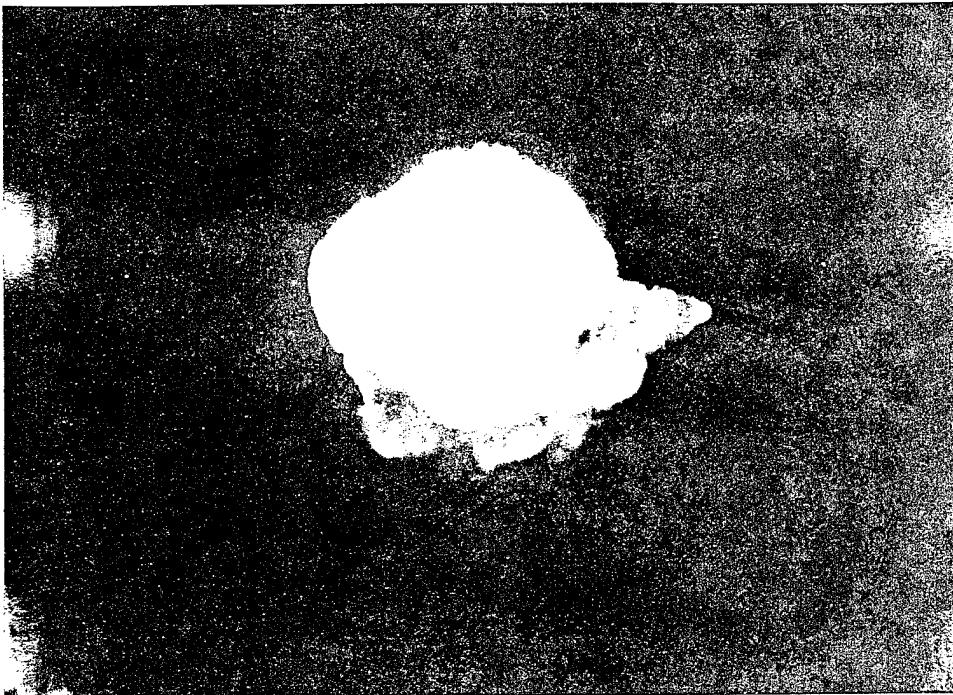
Time: 2.02 msec



Camera: E-6

Station: 527.02

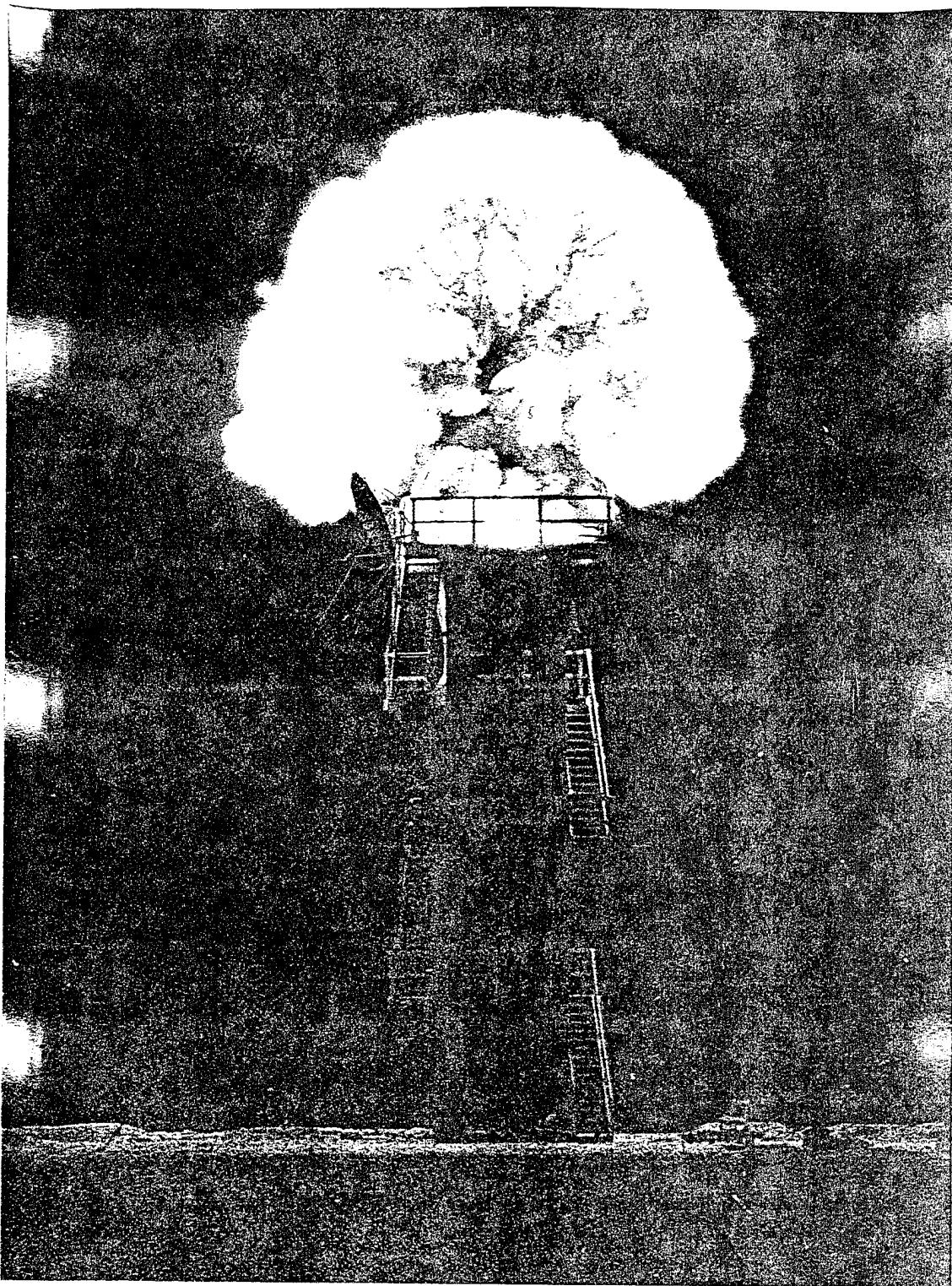
Time: 2.02 msec



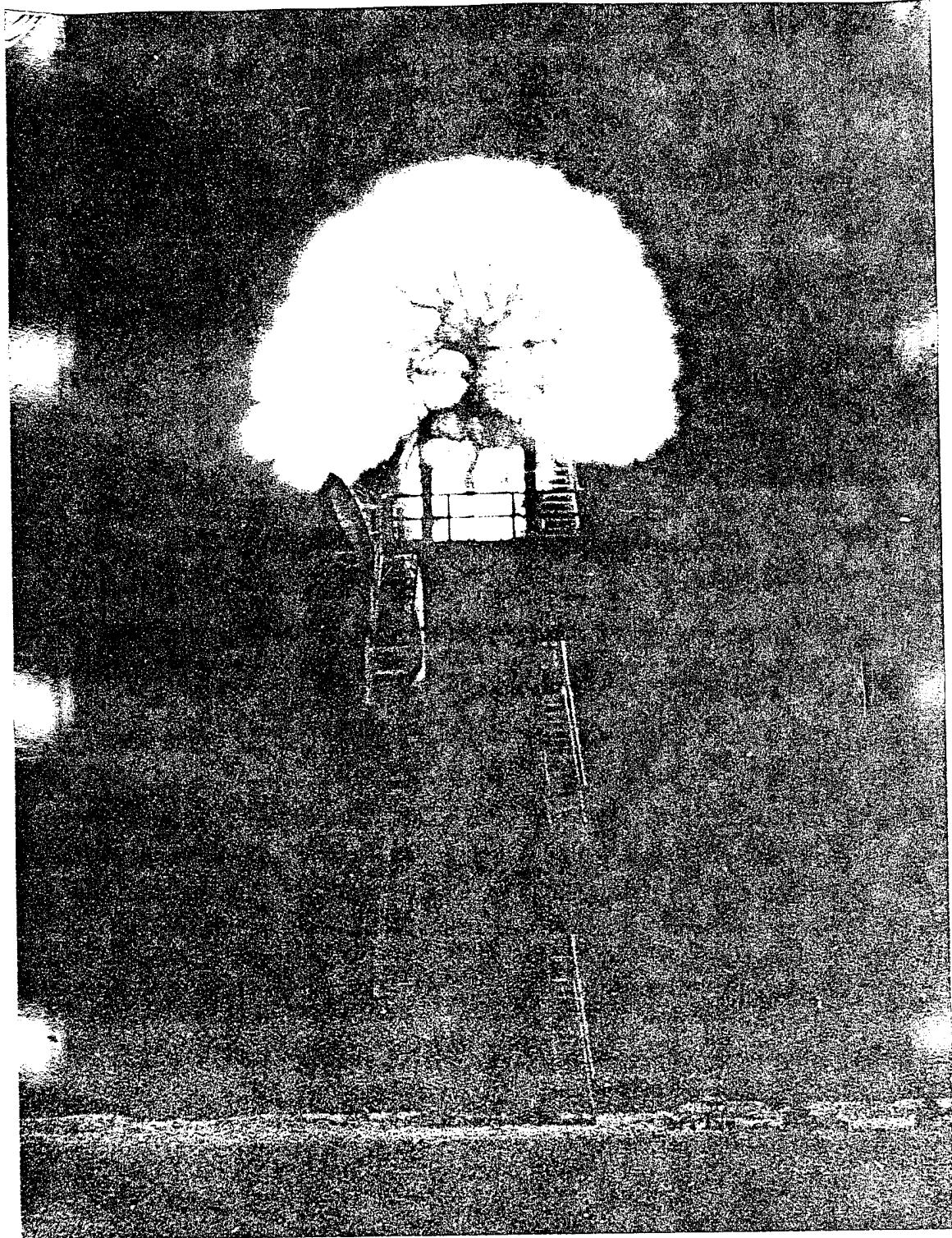
Camera: E-6

Station: 527.02

Time: 6.74 msec



Camera: R-4
Station: 527.01
Time: 0.4995 msec



Camera: R-3
Station: 527.01
Time: 0.9840 msec

Distribution

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1	EG&G, Boston
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